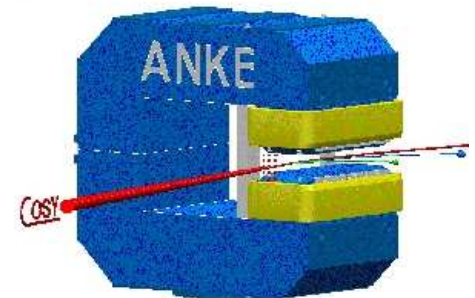


Caucasian-German School and Workshop on Hadron Physics
Tbilisi Sept. 04

Investigation of the ${}^3\text{He}$ η final state in the reaction $d p \rightarrow {}^3\text{He} \eta$ at ANKE

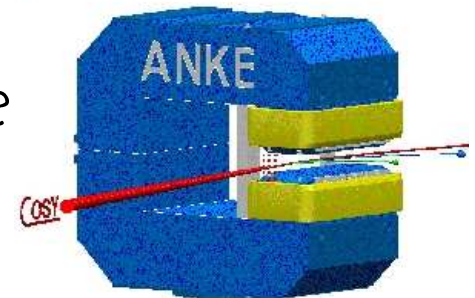
Timo Mersmann
Institut für Kernphysik
Westfälische Wilhelms-Universität
Münster



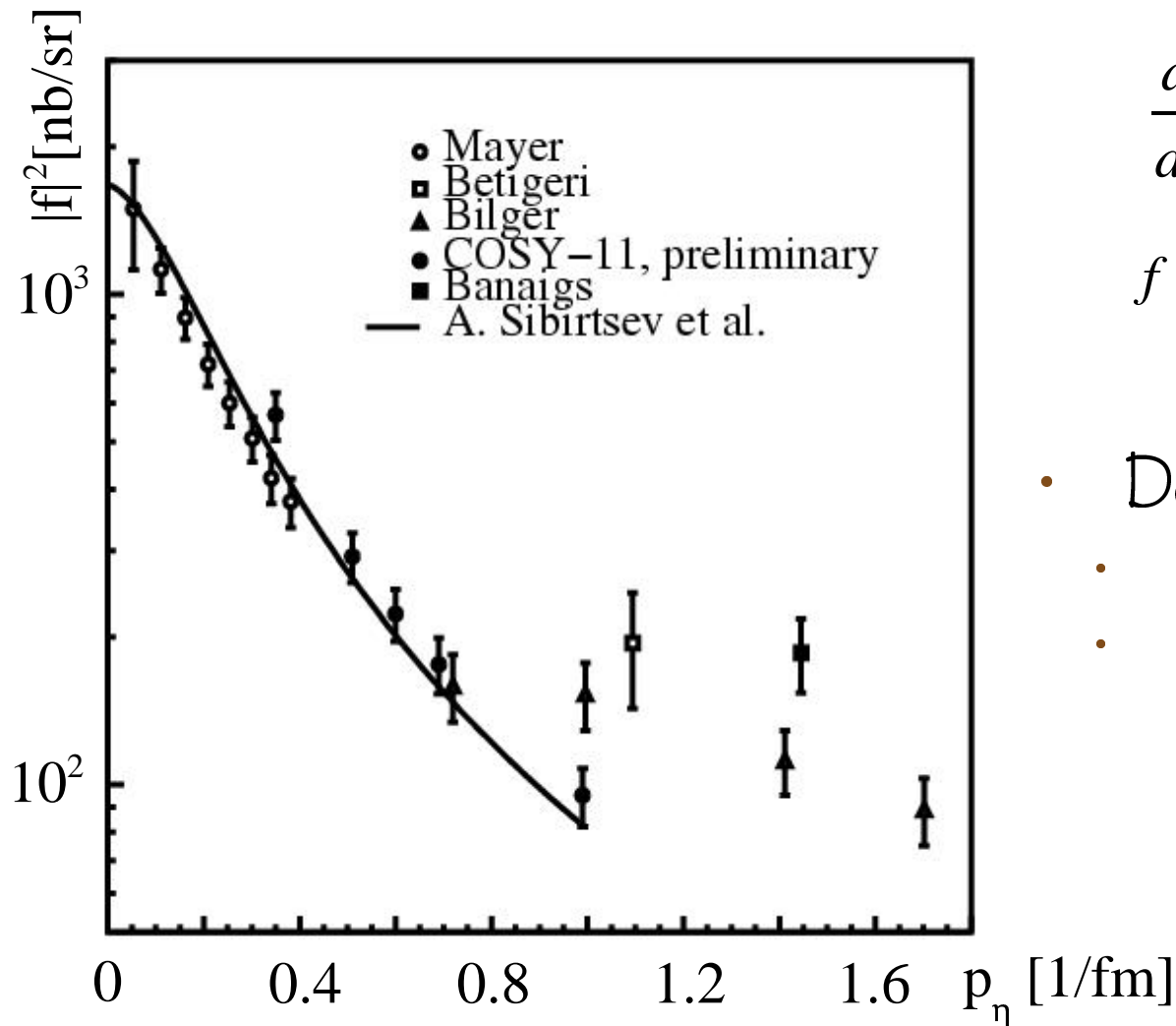
Motivation for $dp \rightarrow {}^3\text{He} \eta$ measurement

ANKE-Proposal 137, April 04

- „The η - ${}^3\text{He}$ scattering length revisited“, Sibirtsev et. al.
 - Existence of η -mesic nuclei still open issue of research
 - Light nuclei like ${}^3\text{He}$ accessible to a microscopic treatment
 - The scattering length is closely related to the properties of a bound state
 - The magnitude of the real part of the scattering length can be extracted from the energy dependency of the production cross section
 - A “Strong hint for a bound state” is possible
- New $dp \rightarrow {}^3\text{He} \eta$ measurements are required !!!



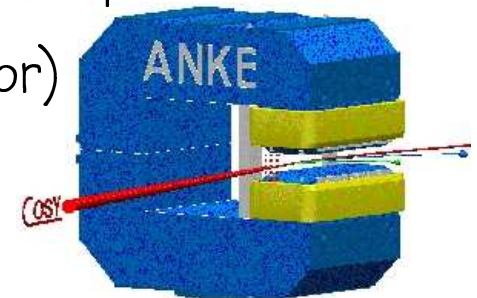
Transition amplitudes $|f|^2$ for $dp \rightarrow {}^3\text{He} \eta$



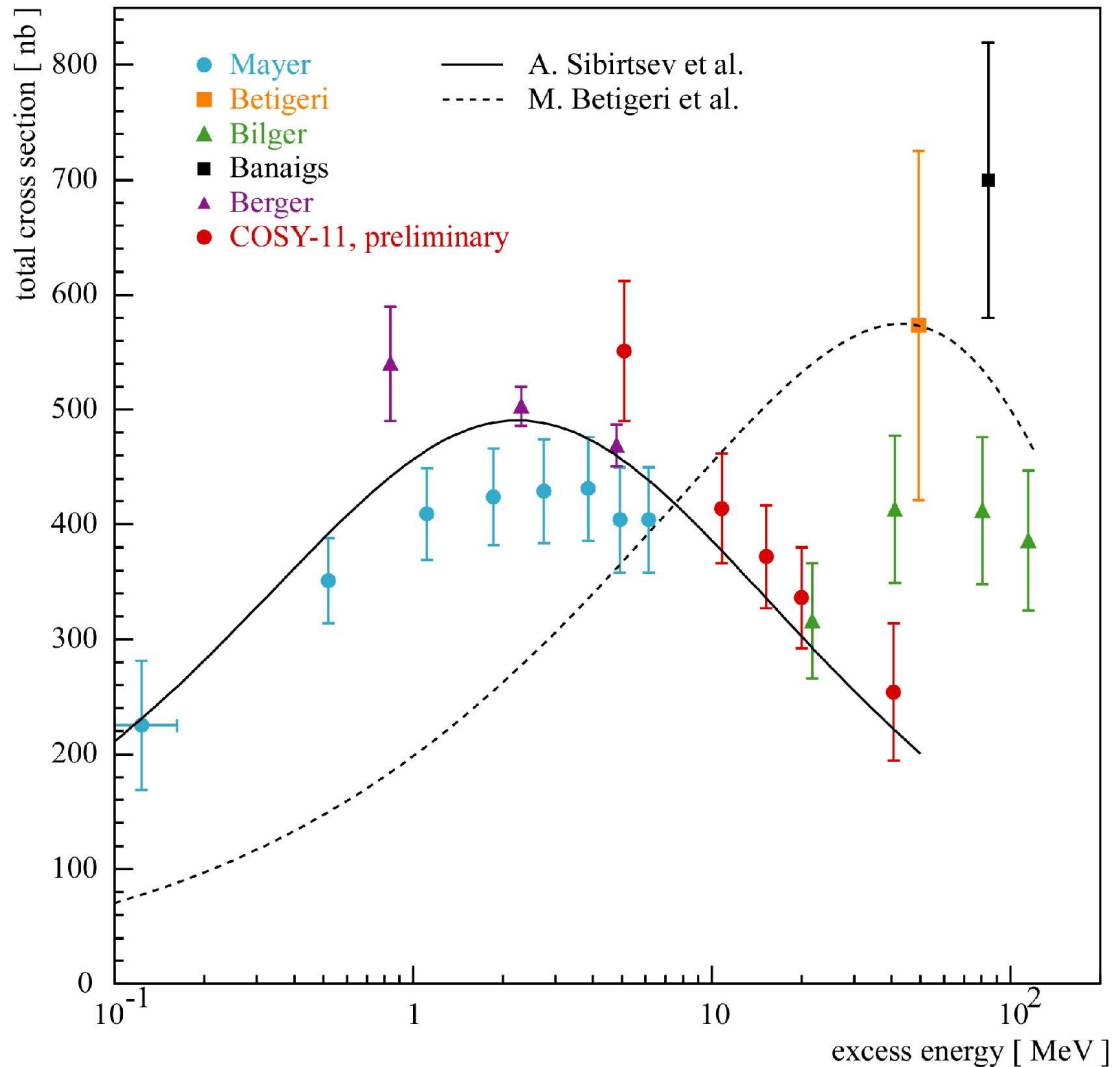
$$\frac{d\sigma}{d\Omega} = \frac{p_\eta}{p_d} \cdot |f(p_\eta)|^2$$

$$f(p_\eta) = \frac{f_p}{1 - i p_\eta \cdot a_{\eta^3\text{He}}}$$

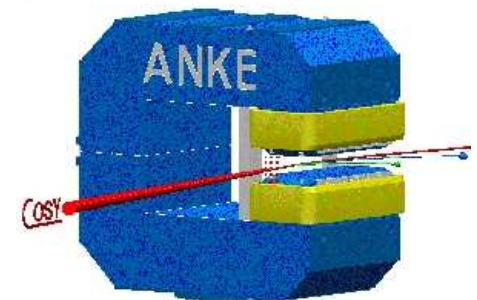
- Determination of:
 - Transition amplitude f
 - Scattering length a
(f_p : s -wave production operator)



Discrepancies for the available data



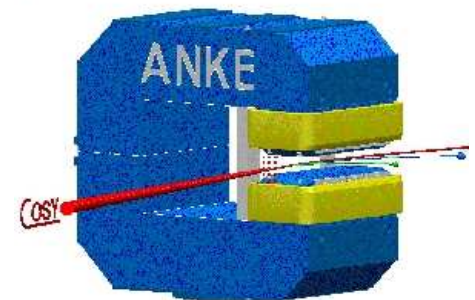
- near threshold (Mayer, Berger)
- at higher excess energies ($Q \approx 60$ MeV)



Goals for a $dp \rightarrow {}^3\text{He} \eta$ measurement

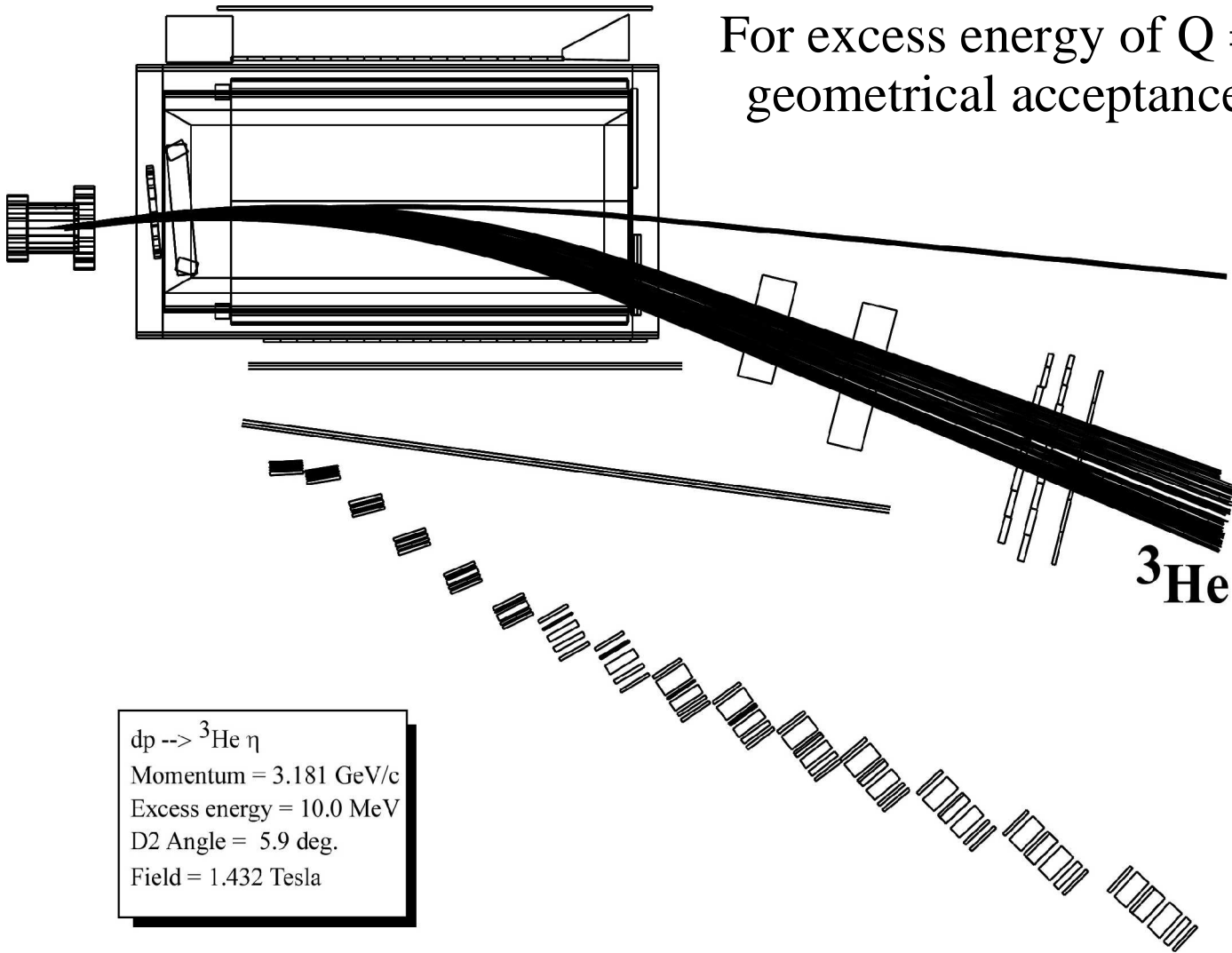
- Precise measured energy dependency of the cross section
 - near threshold
 - up to intermediate excess energies
- Angular spectra of the η meson (above 5 MeV excess energy)
 - full angular acceptance in $\cos(\theta)$ is required
- Minimisation of systematic uncertainties
 - one experimental setup for all investigated excess energies
 - small acceptance uncertainties

High statistic measurements on total and differential cross sections at several excess energies are needed

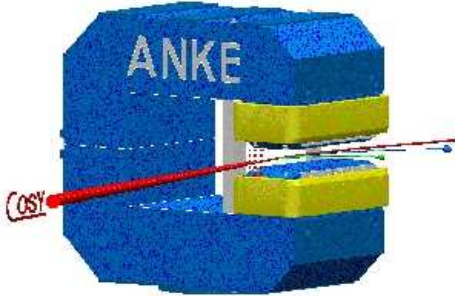


Geometrical acceptance for $dp \rightarrow {}^3\text{He } \eta$

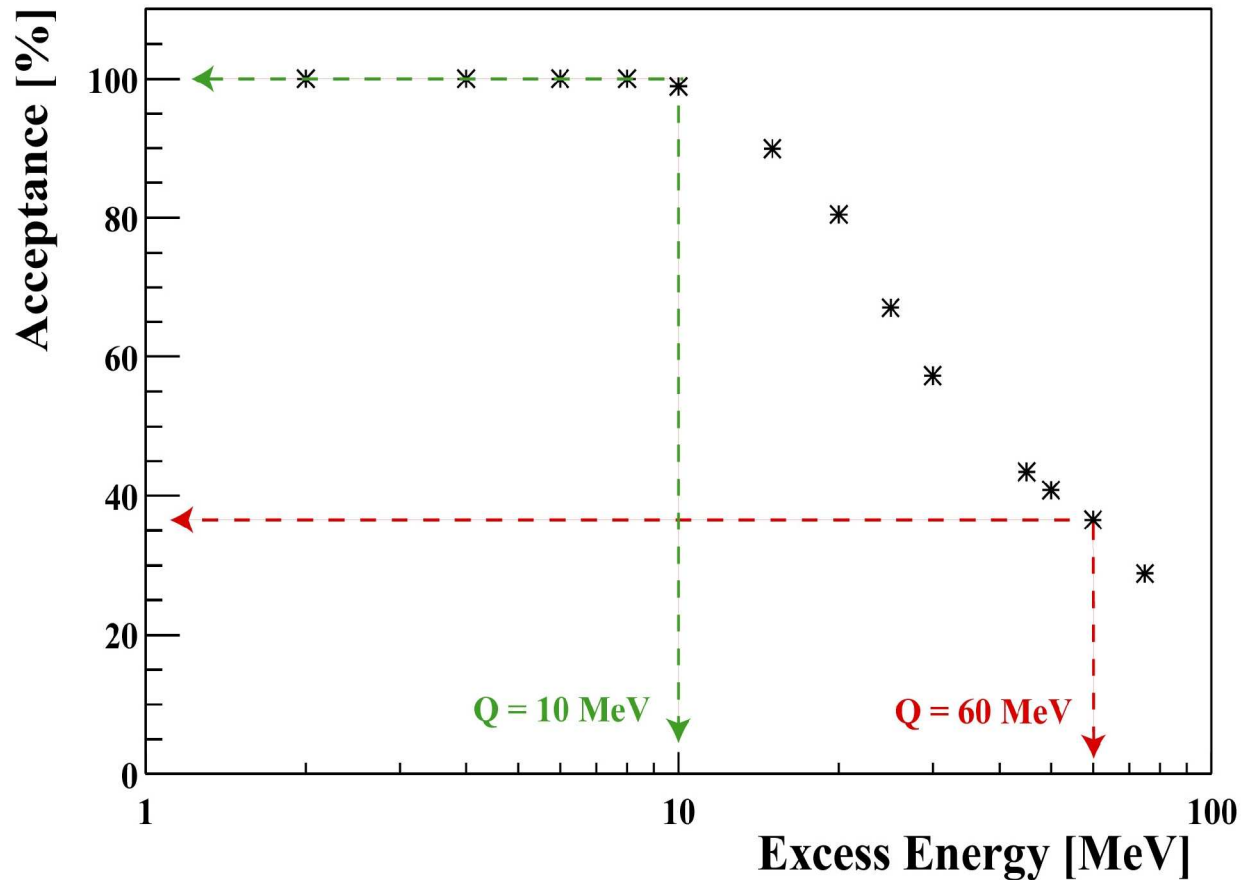
For excess energy of $Q = 10 \text{ MeV}$:
geometrical acceptance $\approx 100 \%$



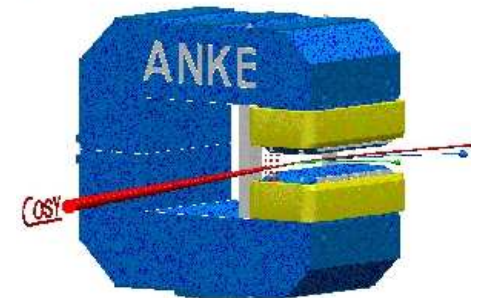
$dp \rightarrow {}^3\text{He } \eta$
 Momentum = 3.181 GeV/c
 Excess energy = 10.0 MeV
 D2 Angle = 5.9 deg.
 Field = 1.432 Tesla



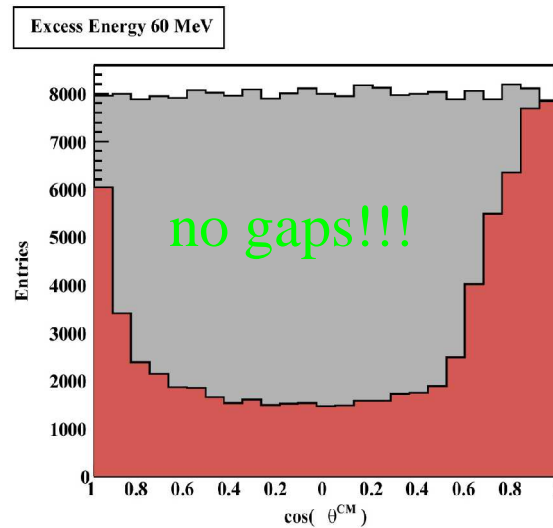
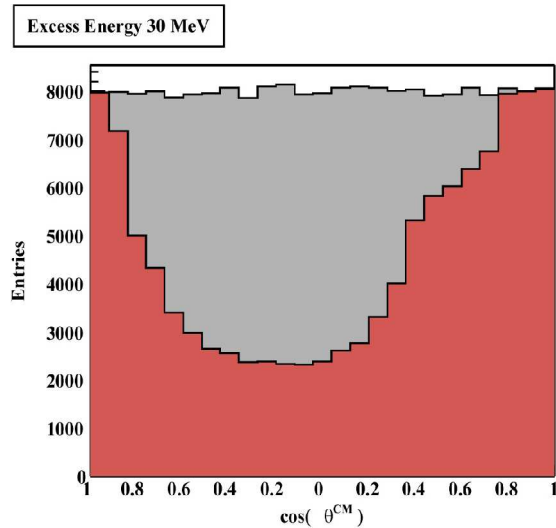
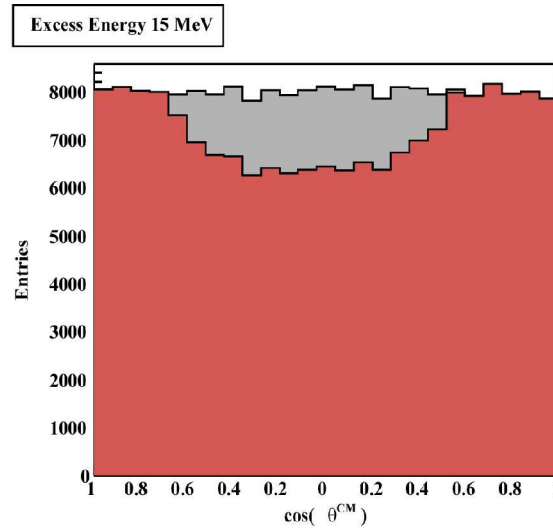
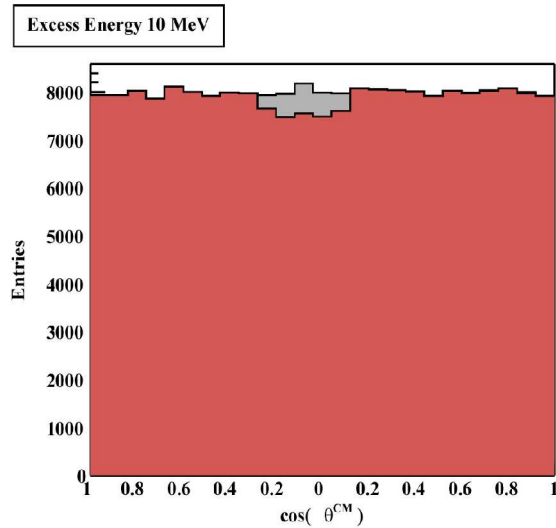
Geometrical acceptance for $dp \rightarrow {}^3\text{He} \eta$



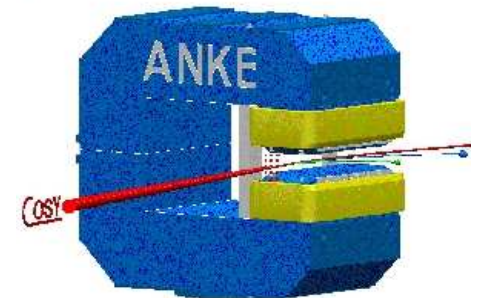
- For excess energies up to 10 MeV: detector acceptance $\approx 100\%$
- No acceptance corrections needed



Angular acceptance for $dp \rightarrow {}^3\text{He} \eta$



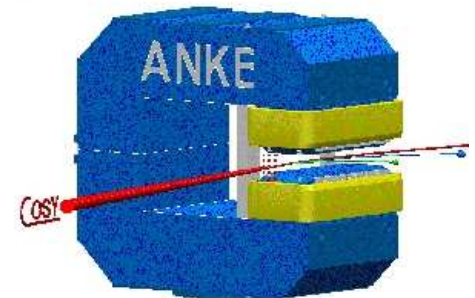
- Grey: phase space generated events
- Red: accepted events



ANKE is the perfect facility for the required $dp \rightarrow {}^3\text{He} \eta$ measurement

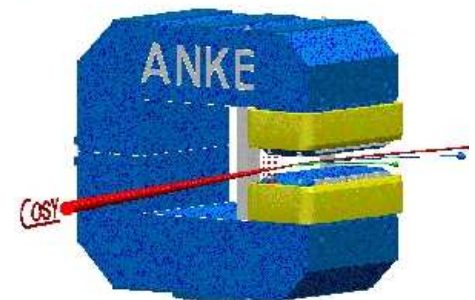
- High Acceptance, high statistics
- No systematical uncertainty induced by acceptance estimations for near threshold measurements
- No acceptance gaps in $\cos(\theta)$ even for 60 MeV excess energy

► Motivation for a proposal at ANKE



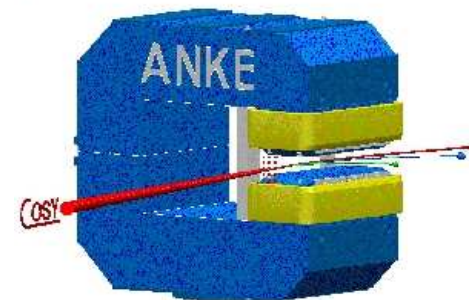
ANKE-Proposal 137 (PAC April 04)

- Request for *two weeks* of beamtime
 - Measurements at excess energies of 1, 2, 4, 6, 8, 10 MeV each one day using *stochastic cooling*
 - Measurement at excess energy of -5 MeV (one day) using stochastic cooling for background analysis
 - Measurement at excess energies of 15 and 30 MeV (each one day) and of 45 and 60 MeV (each two days) without stochastic cooling



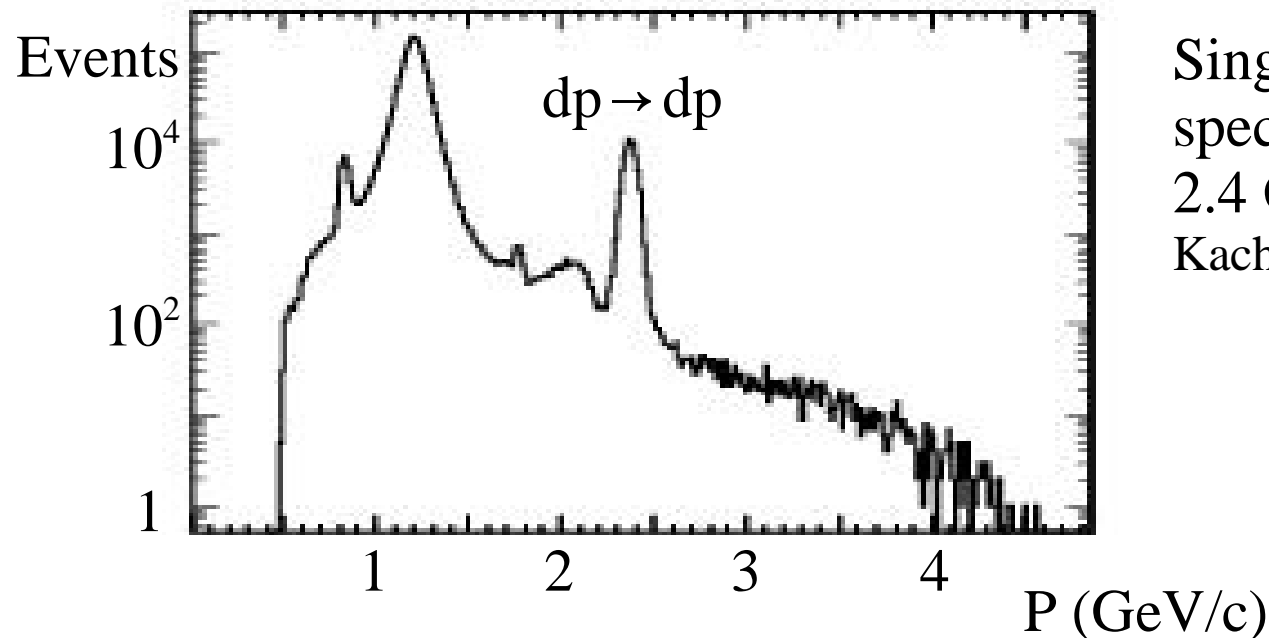
PAC-Decision and realisation

- PAC approved **one "long" week** (November 04)
 - More measurements near threshold are required
- Idea: Measurement of the subthreshold and near threshold region in a continuous ramp for several days (like in ANKE-Proposal 139: $dd \rightarrow {}^3\text{He} N \pi / t N \pi$)
- At least measurement of the reaction at three higher excess energies
- No use of stochastic cooling (due to the continuous ramp no problems with beam energy loss and beam energy smearing)

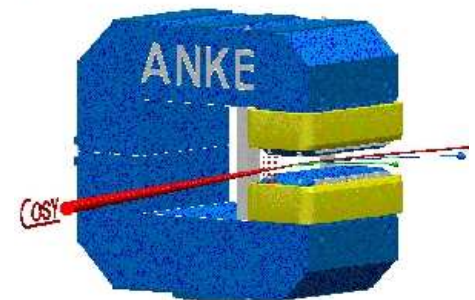


Absolute normalisation of the data

- dp-elastic scattering, available data:
N. Katayama et al. (Nucl. Phys. A438 (1985) 685)
- Deuteron in Fd-System (prescaled Fd-Or-Trigger)



Single track momentum spectrum for a d-beam of 2.4 GeV/c (Taken from A. Kacharava et al. Proposal 125.1)



Thanks to all contributing to the proposal and helping to realise the experiment

- Thanks for the support on:
 - The theory for the proposal
 - ANKE-detector-physics
 - Simulation and analysis software
 - Realisation of the needed experimental setup in Nov. 04
 - Physics with polarised deuterium beams
- Thanks for such a nice atmosphere in our collaboration
- Thanks to the organisers of this workshop!!!

